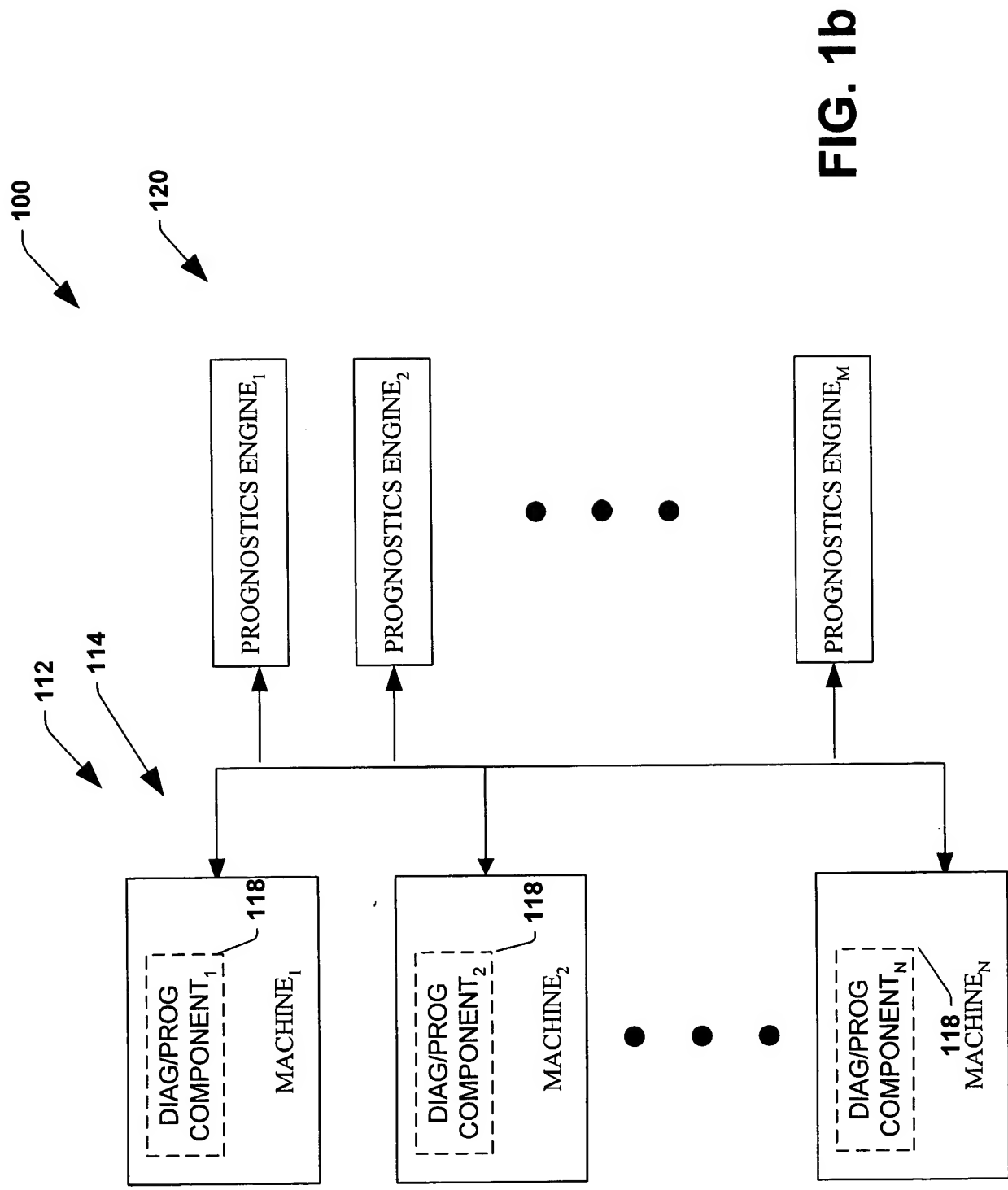
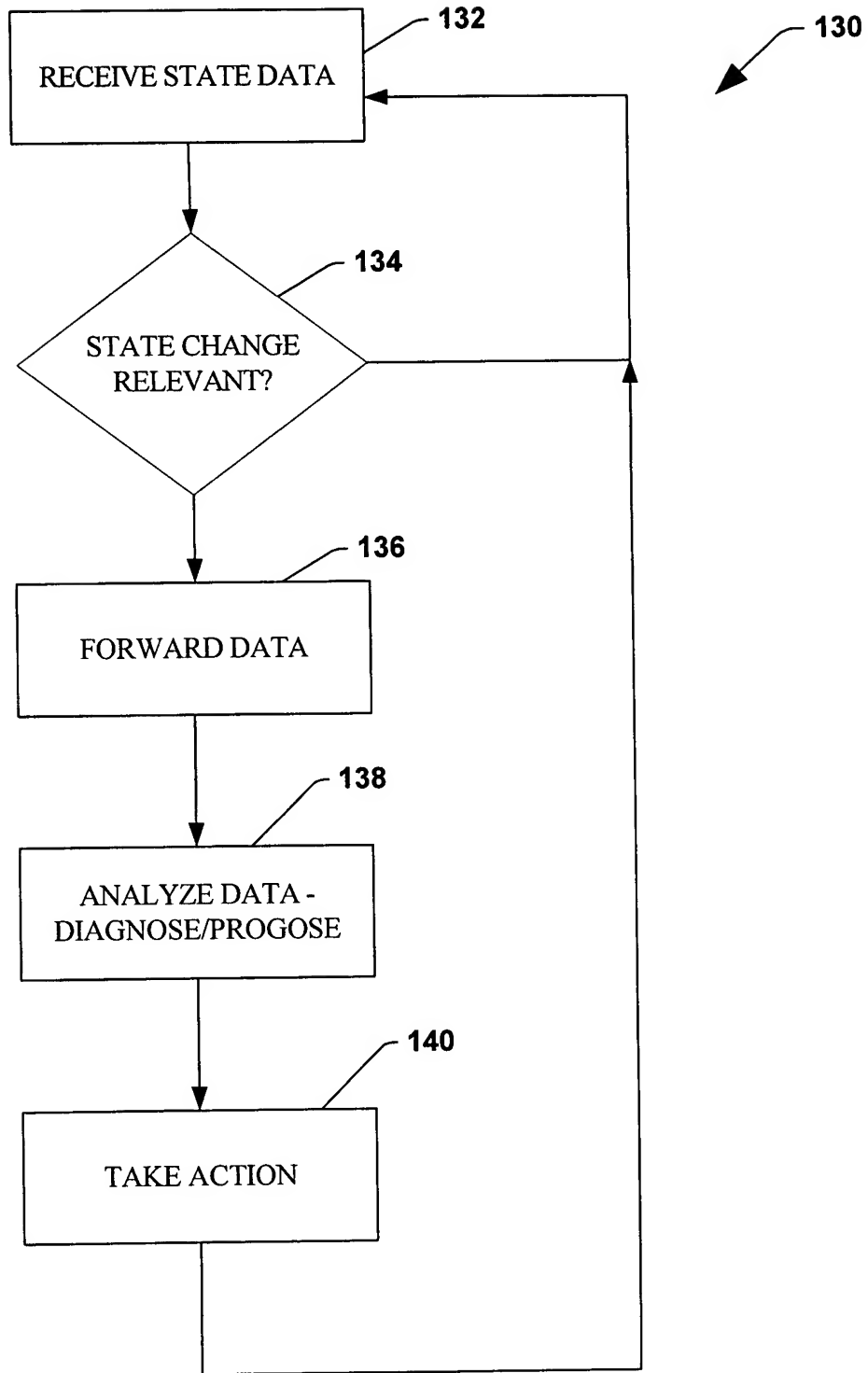


**FIG. 1a**



**FIG. 1b**



**FIG. 1c**

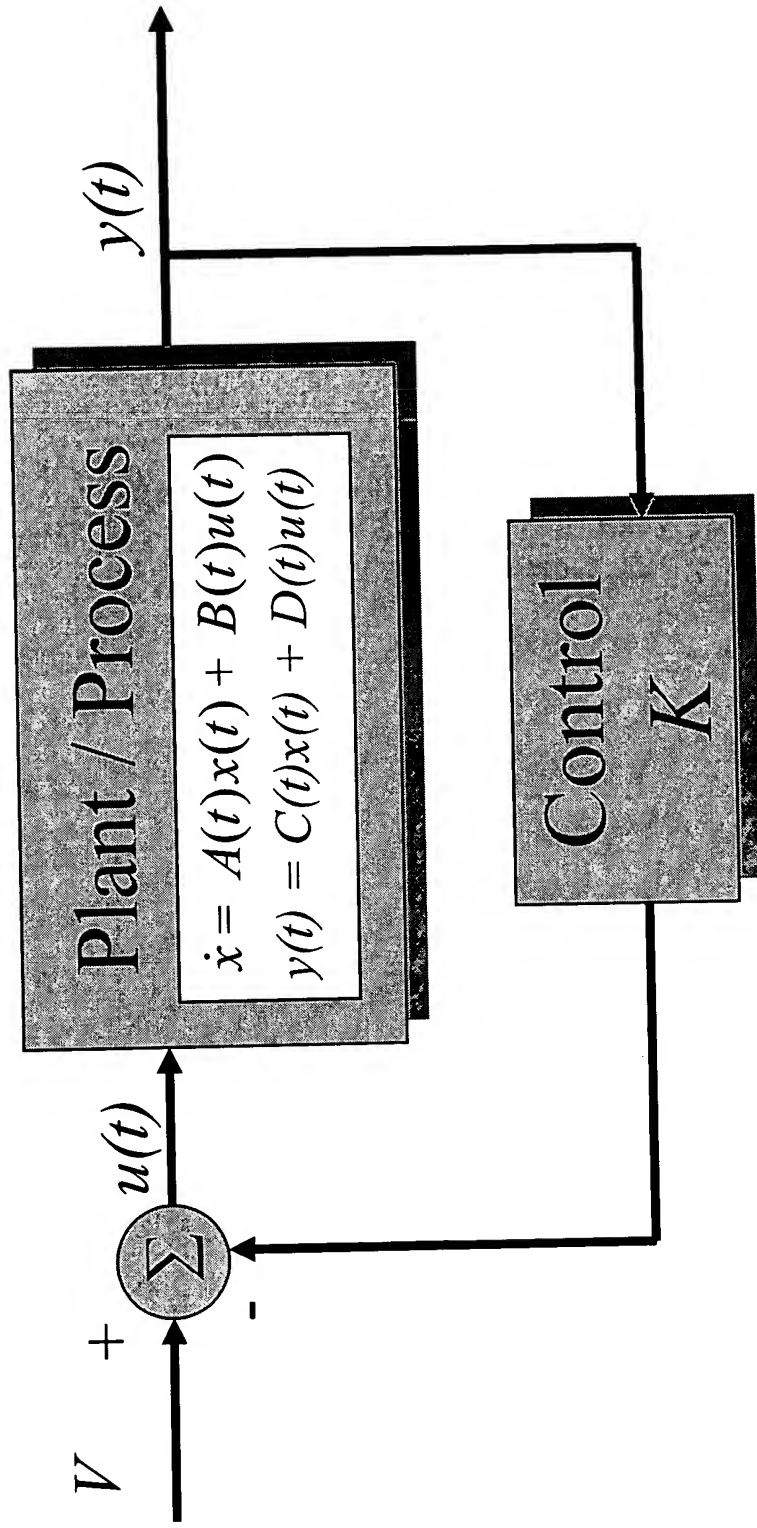


Figure 1d

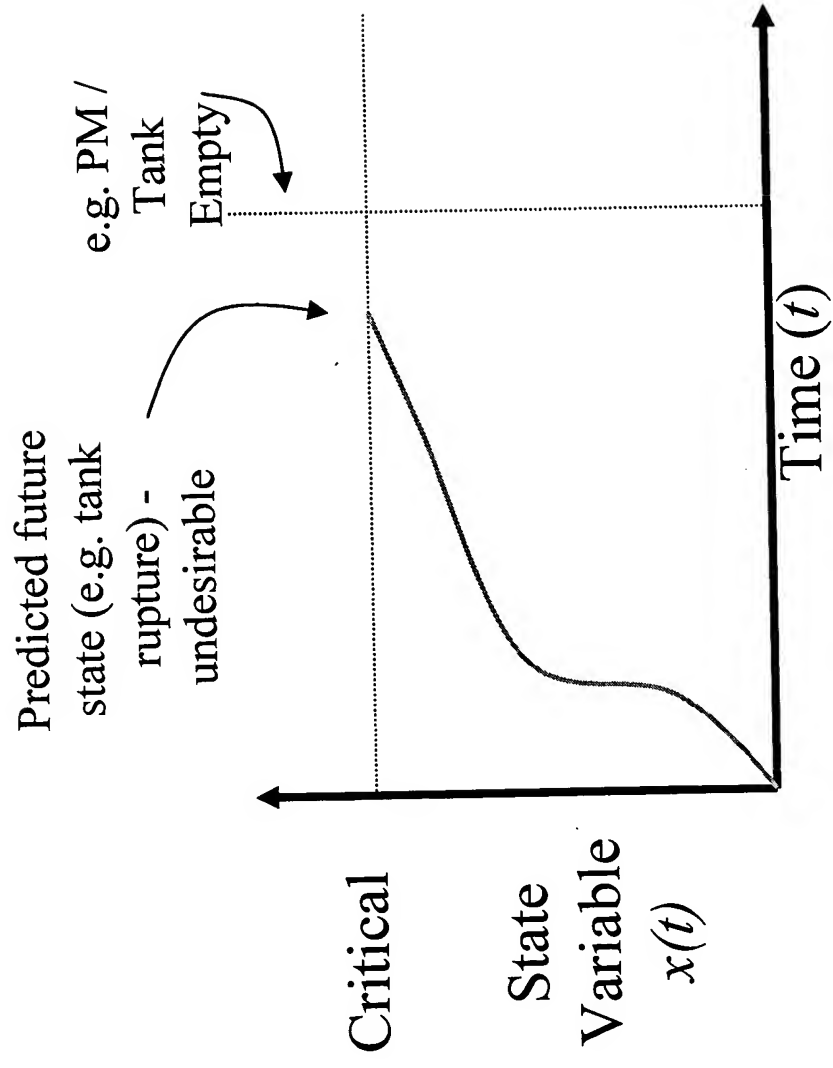
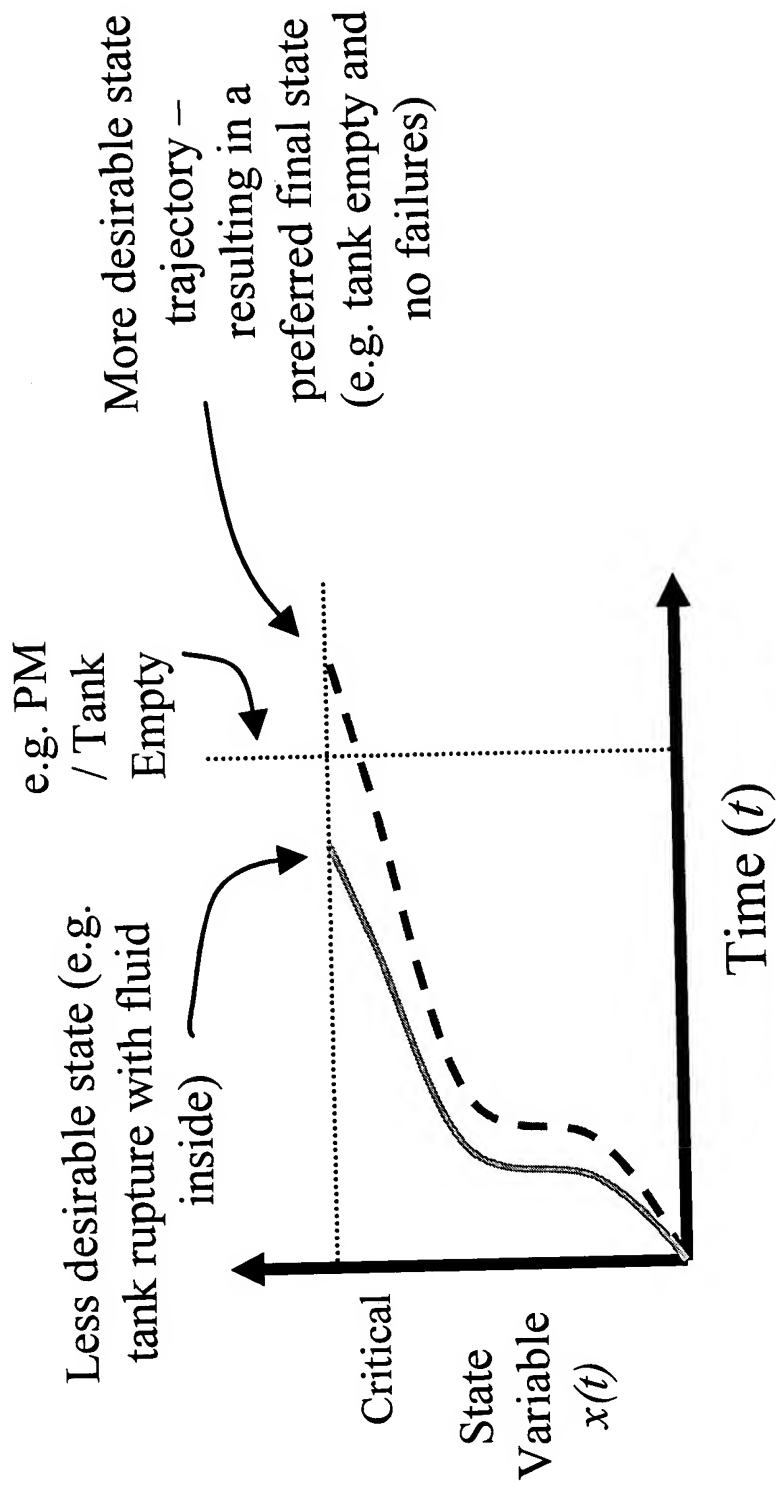
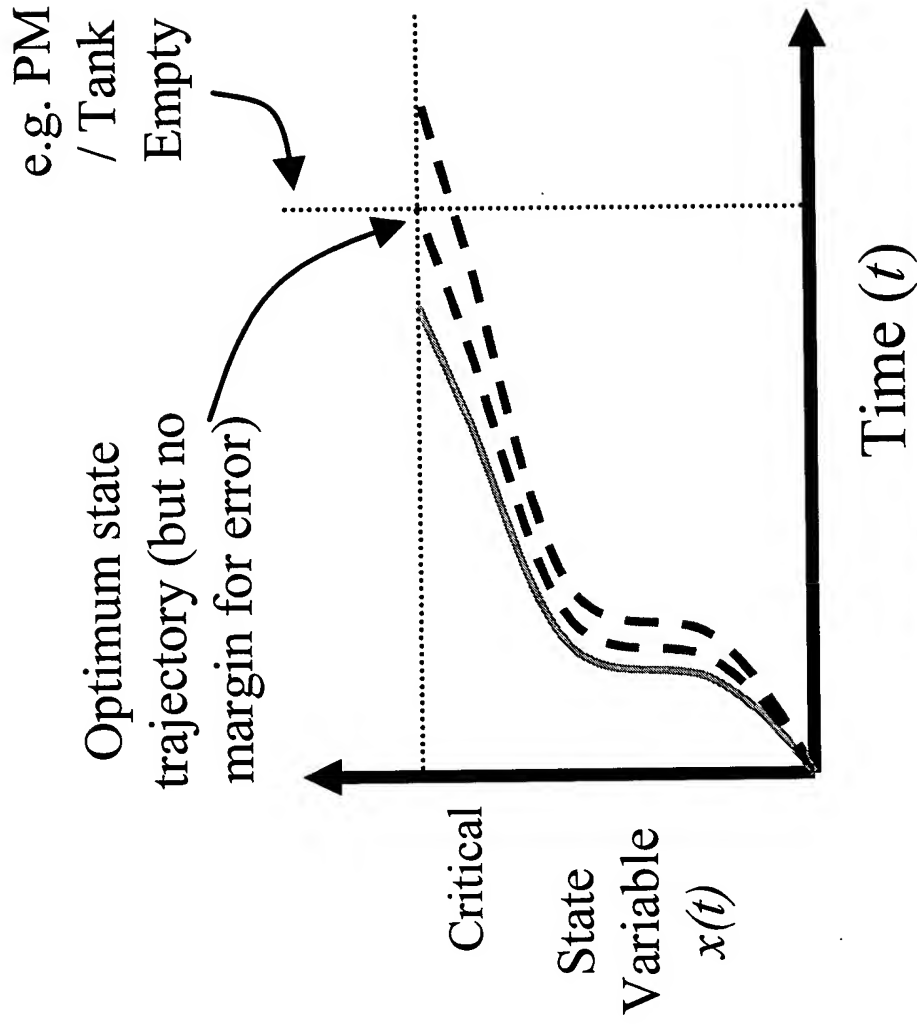


Figure 1e



**Figure 1f**



**Figure 19**

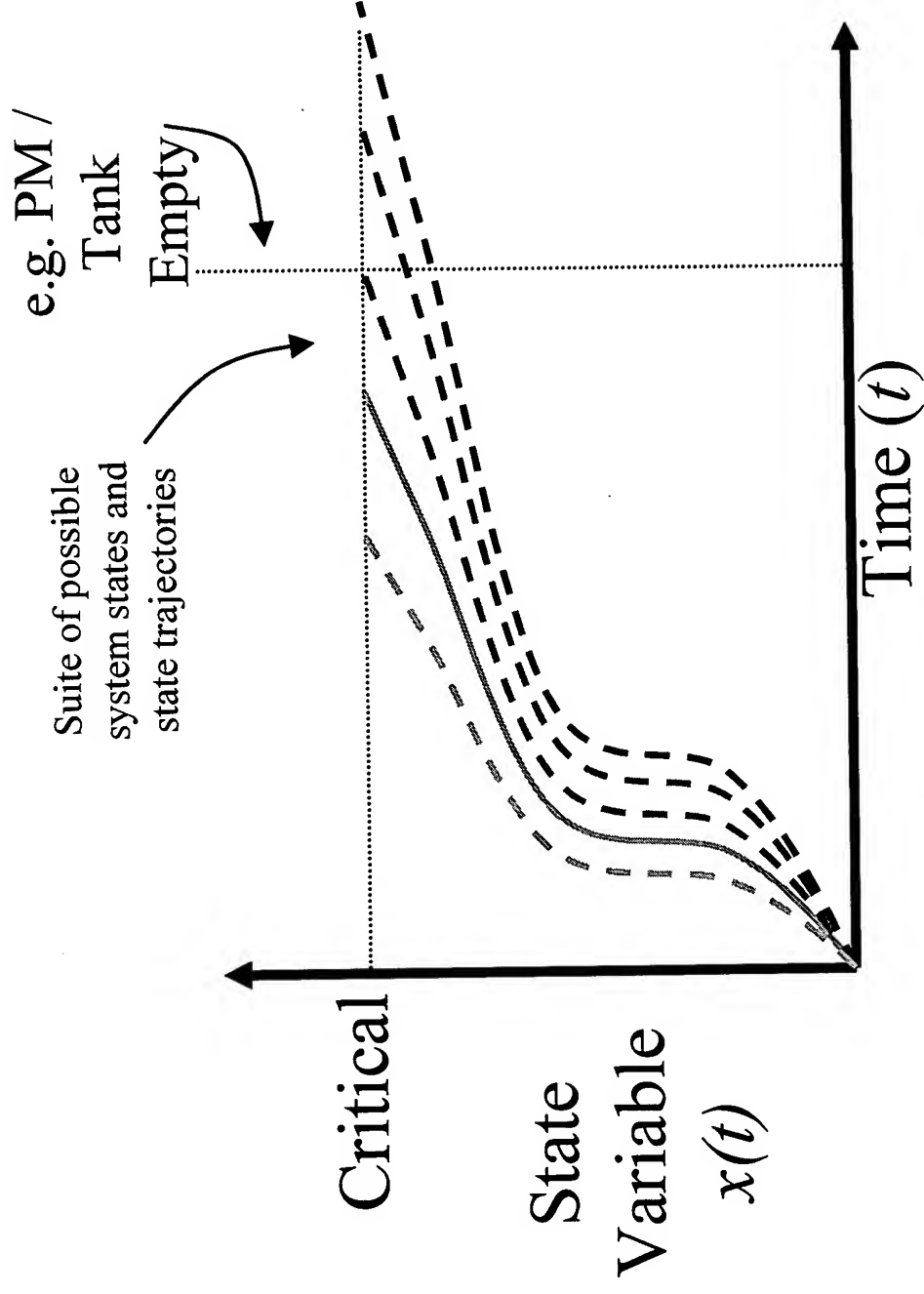


Figure 1h



## Design Implications

Evolving database of design rules & objectives to enhance early failure detection, control capabilities, & reconfiguration options

**Design**  
Diagnostics/  
Prognostics/control-  
based design objectives

- longer life
- fault tolerant
- easier prognostics
- more effective compensating control

Mission / Workload Schedule /  
Environment / Maint. Schedule, etc.

**Plant/Process**

Alteration  
of Real-time  
Control  
System

**Health  
assessment**

**Decision Making  
(recommendation)**

Alteration of Plant / Architecture / Function - future

**Control**  
Dynamic / Multi-Objective Optimization

**Control**

Operator  
Notification

Operating  
Objectives /  
Constraints

Setpoint

## Control Implications

- enable stimulus-response analysis
- control time-life trajectory
- set-prove-disprove hypothesis
- safe (predictable) operation
- safe operation beyond normal operating regimes
- unprecedented optimizing control

**Figure 1i**

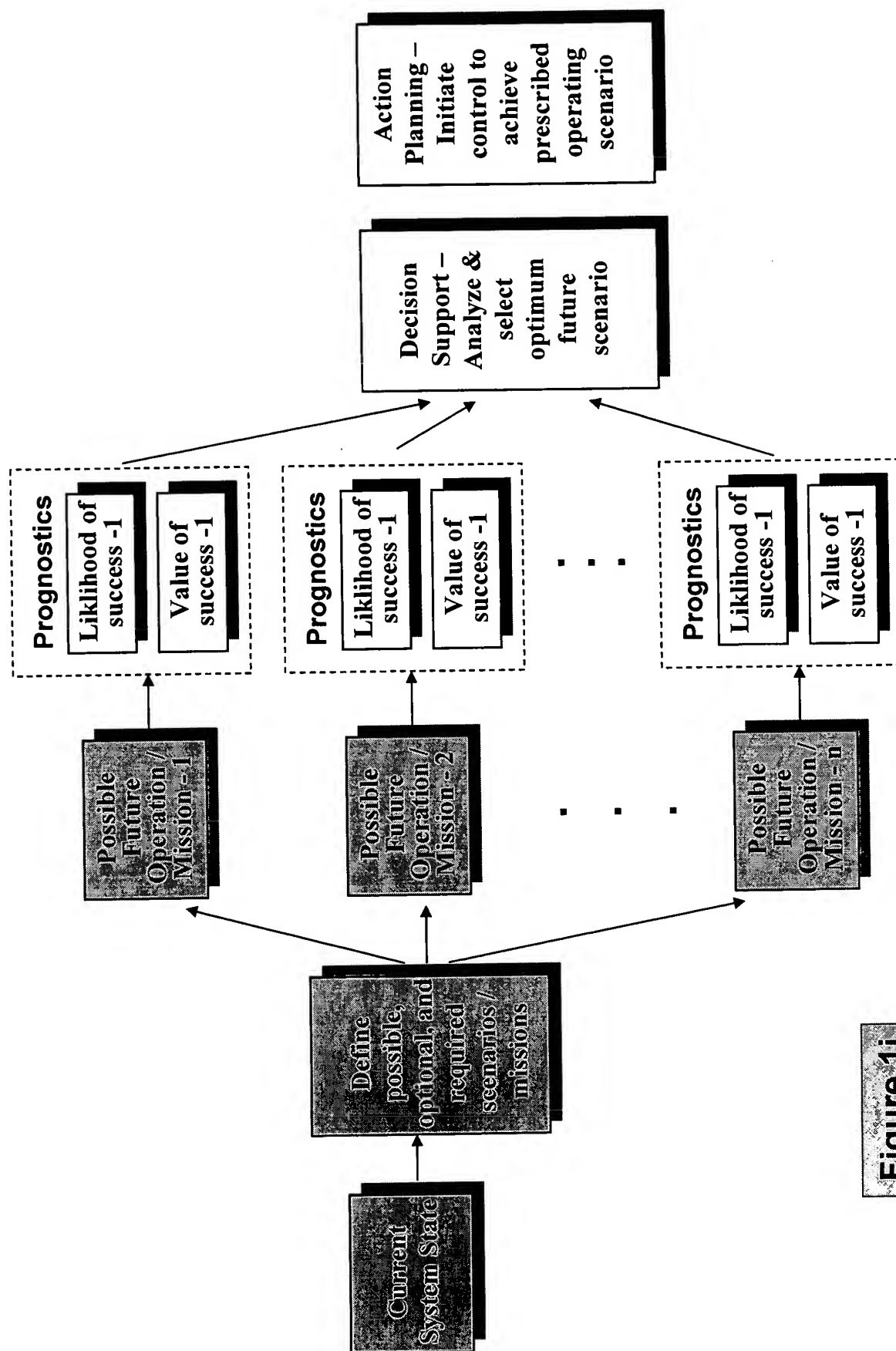


Figure 1j

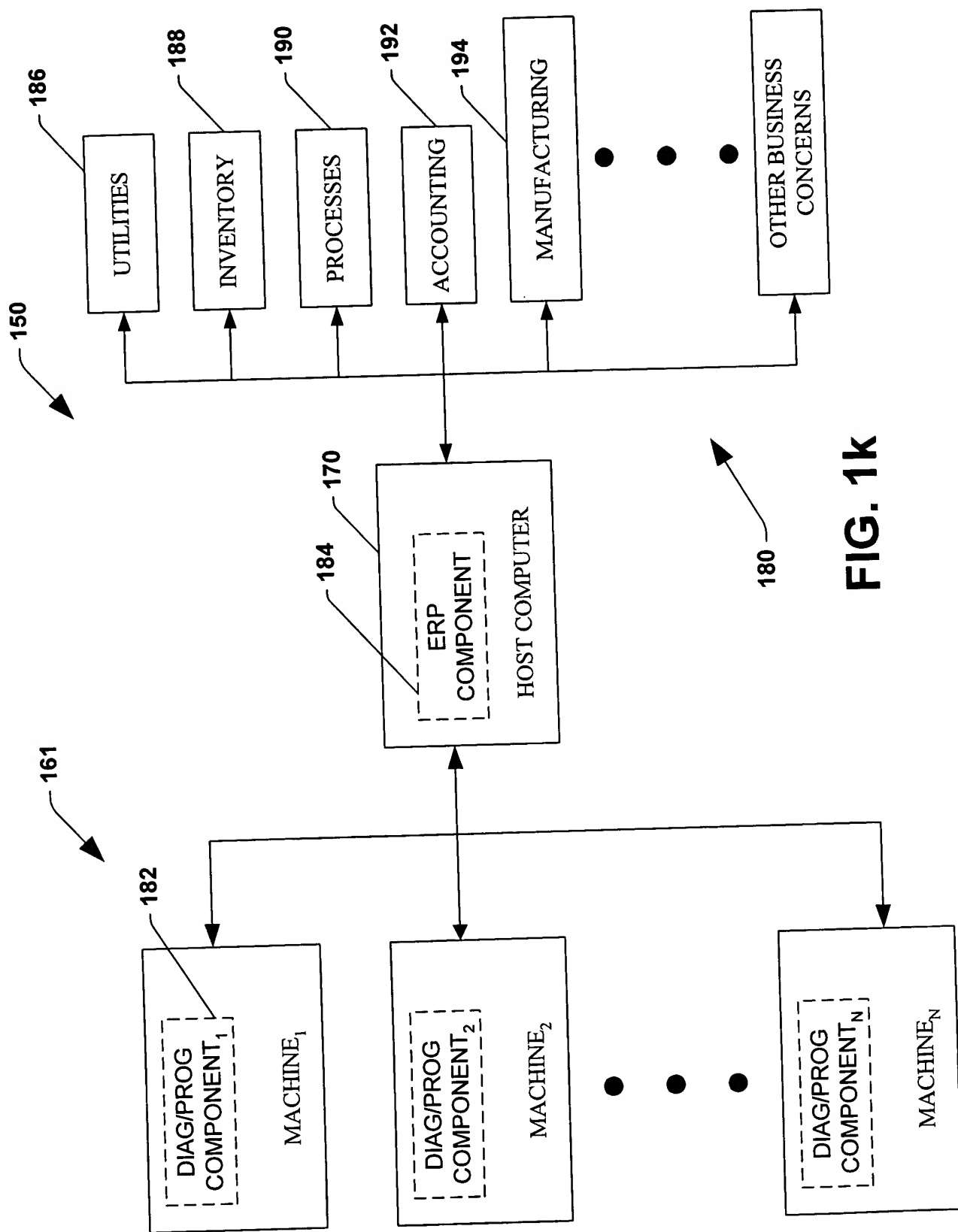


FIG. 1k

Example Pump Usage Profile Over Time

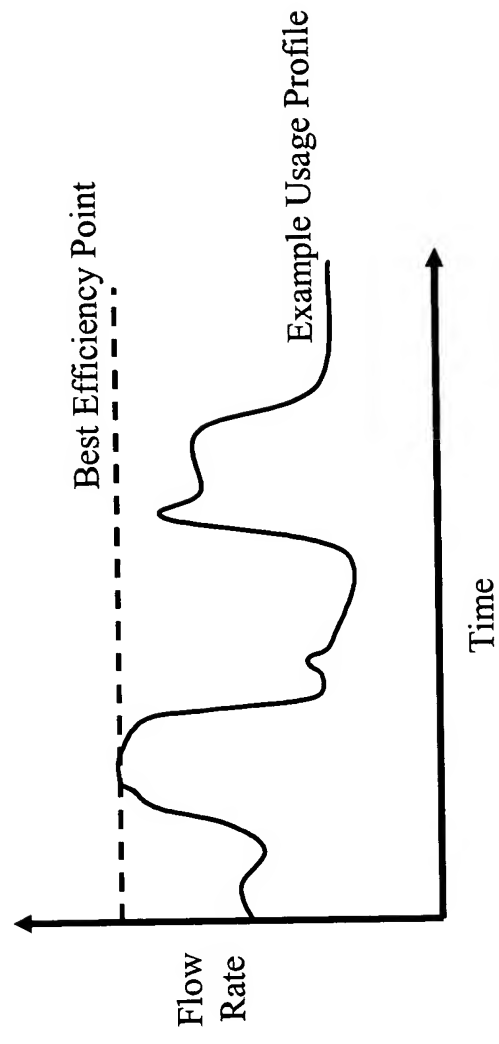


FIG. 2

Cost Function Response Surface and Steepest Decent Technique

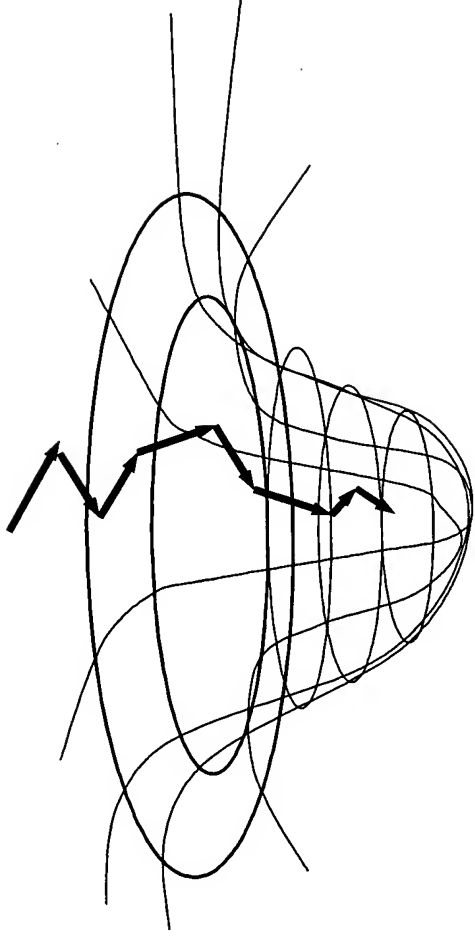
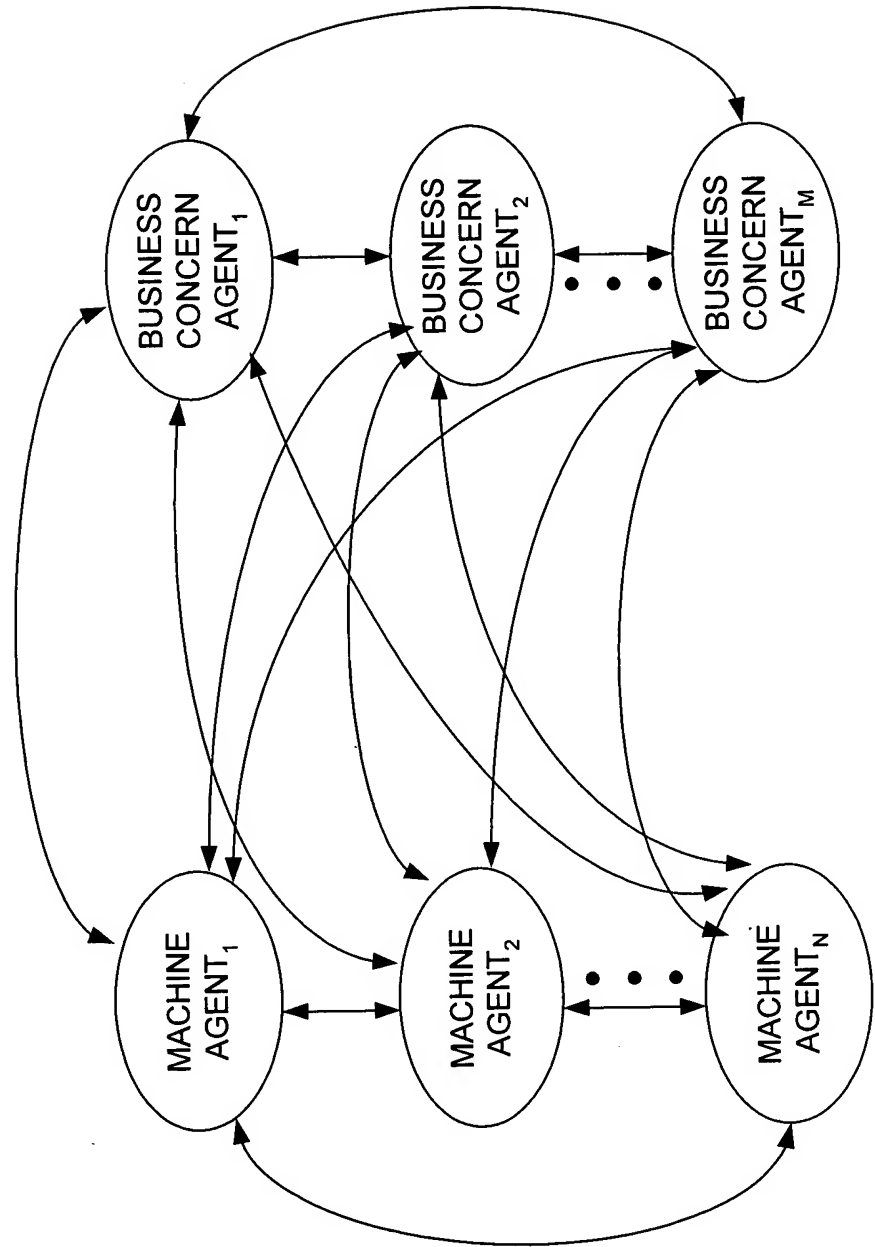


FIG. 3



**FIG. 4**

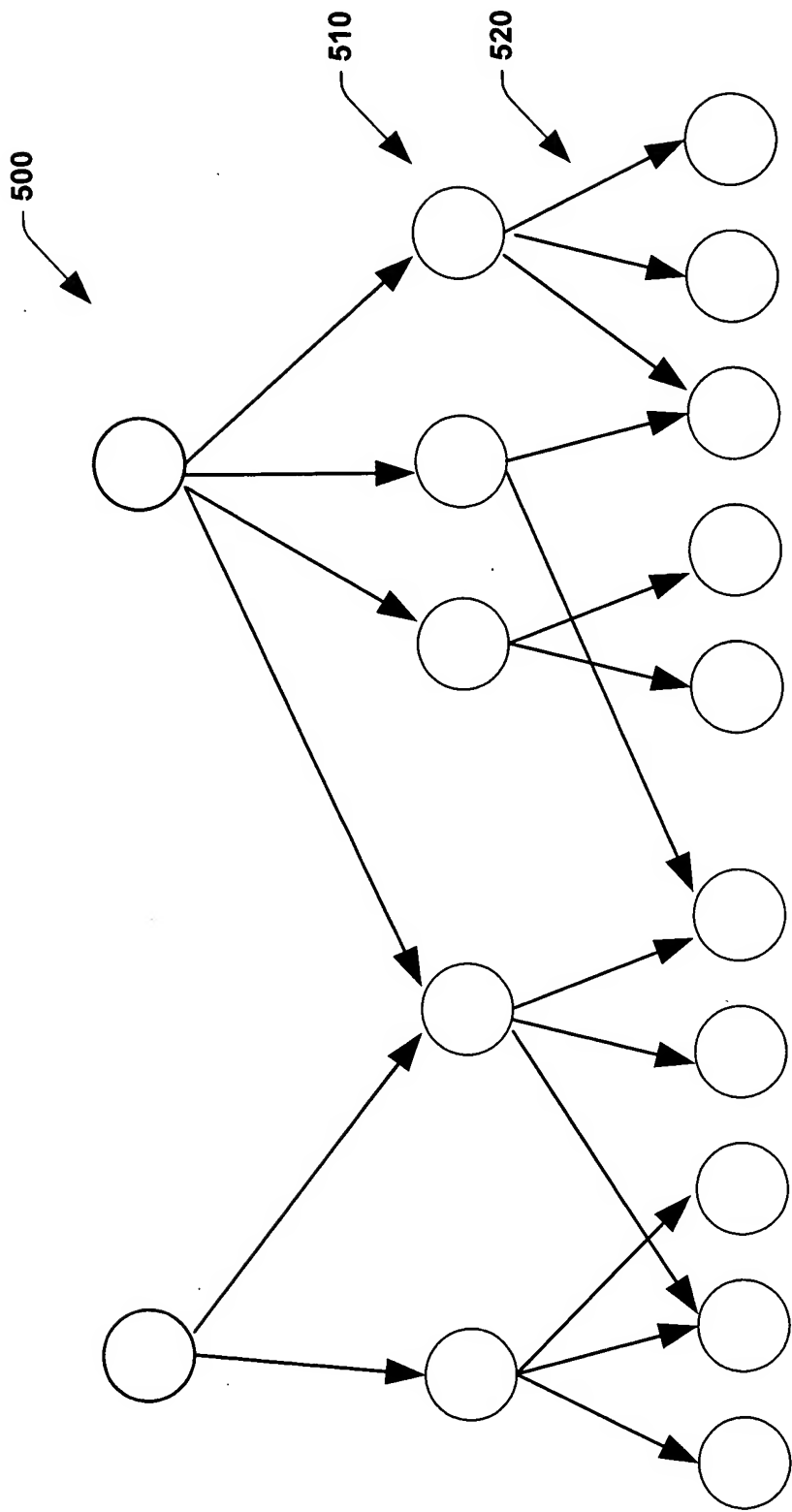


FIG. 5

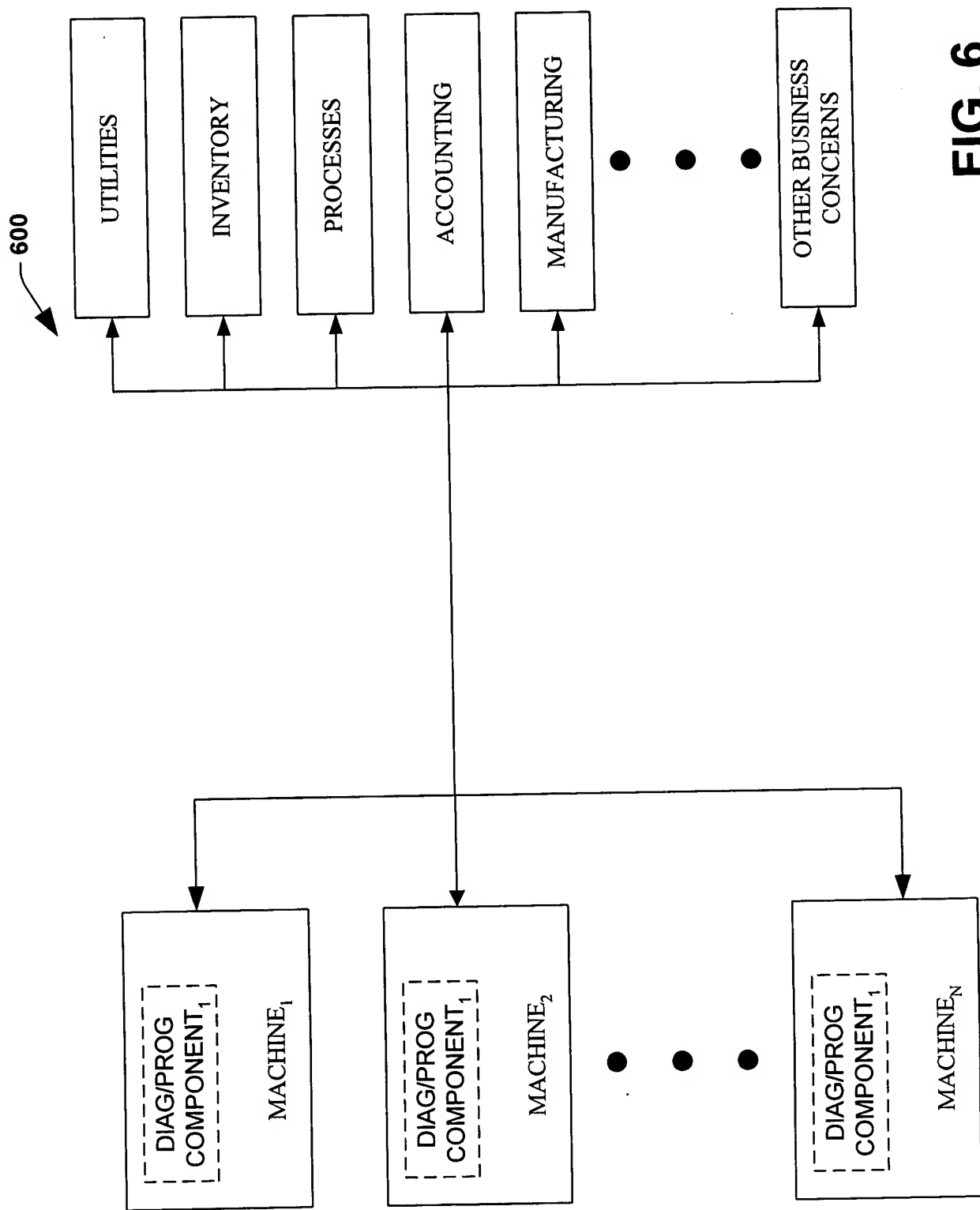


FIG. 6



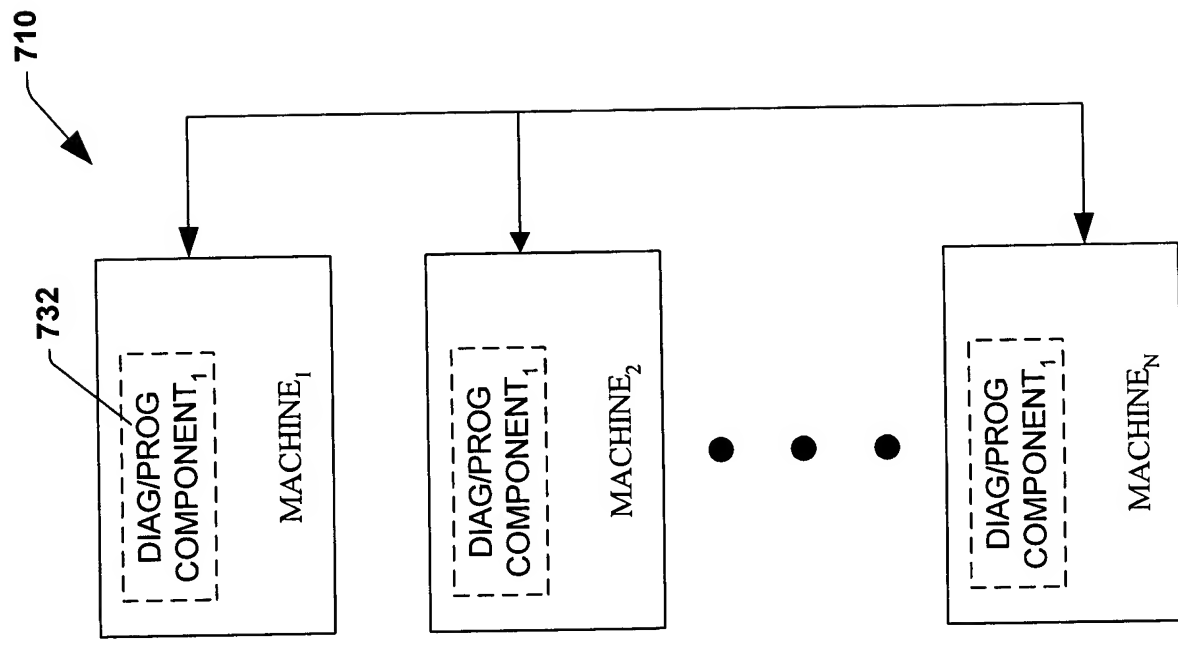
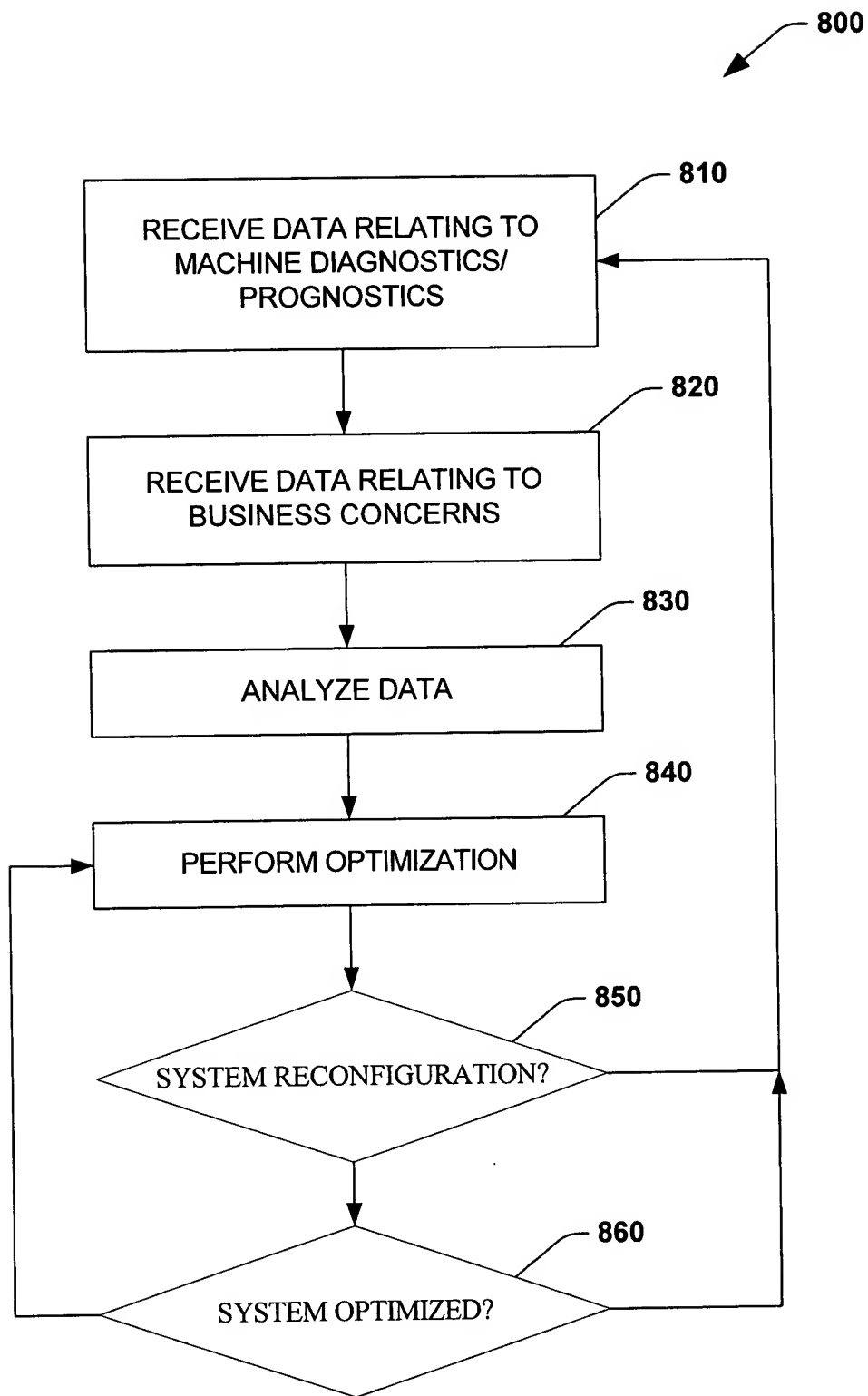


FIG. 7



**FIG. 8**

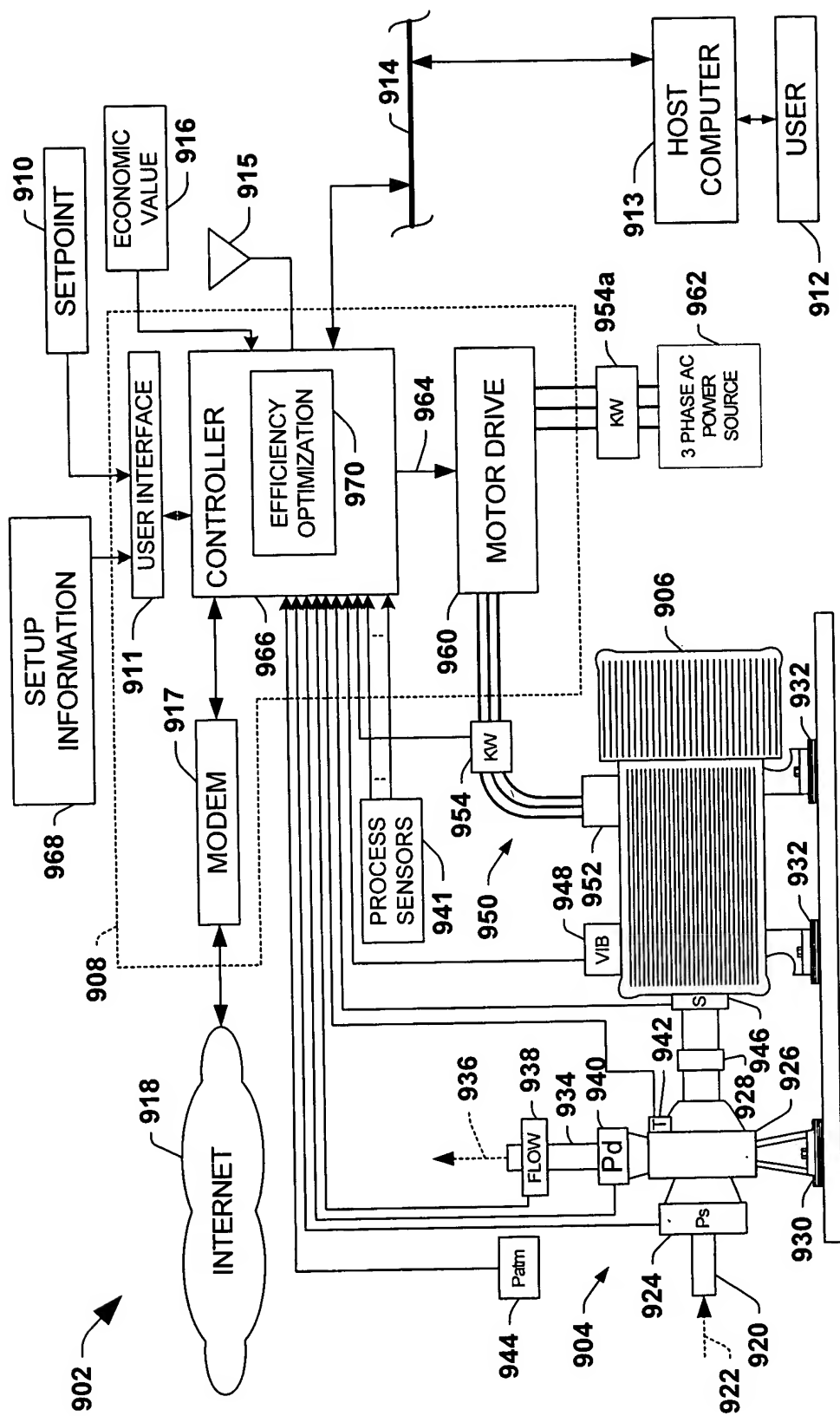
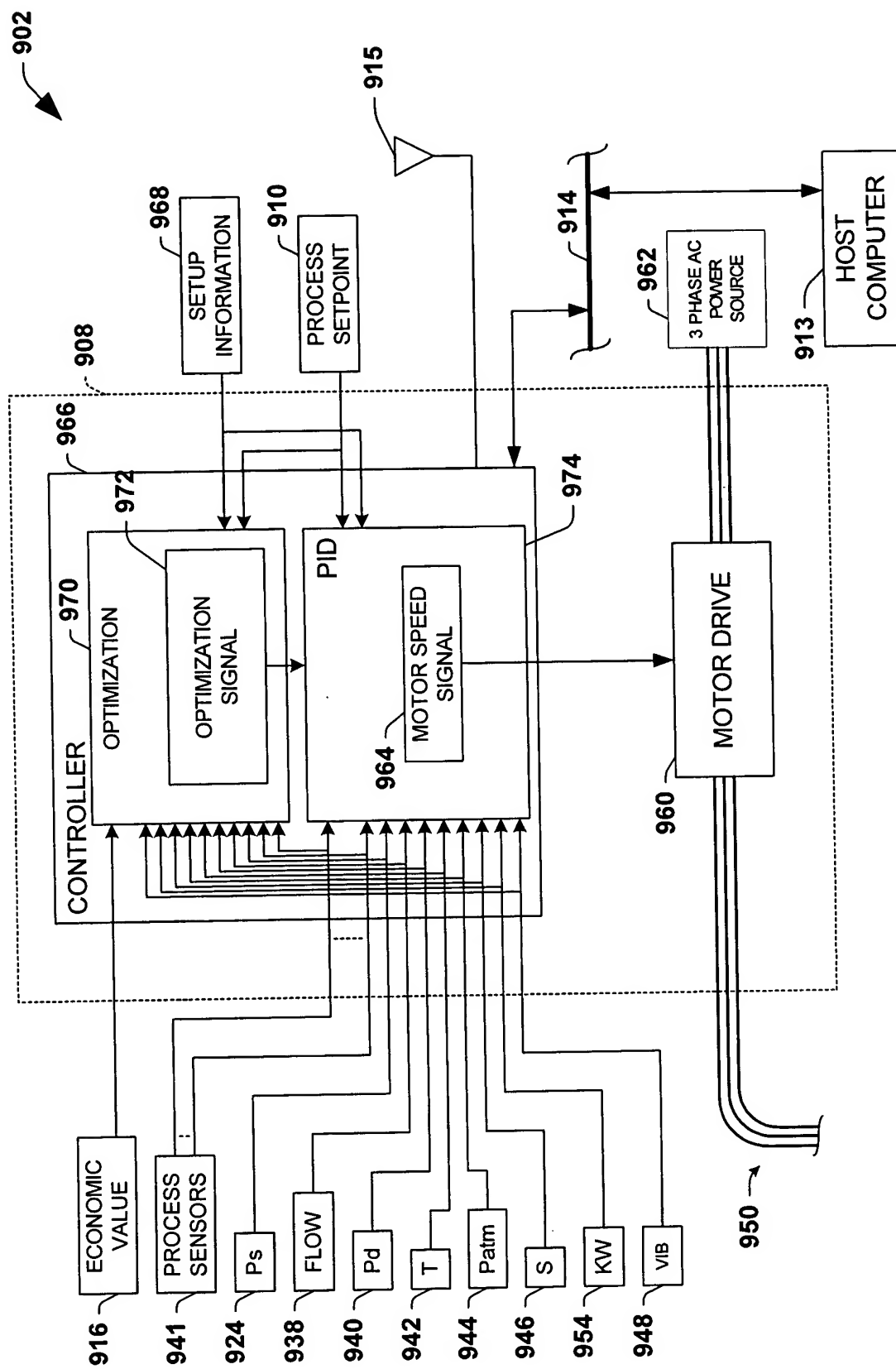
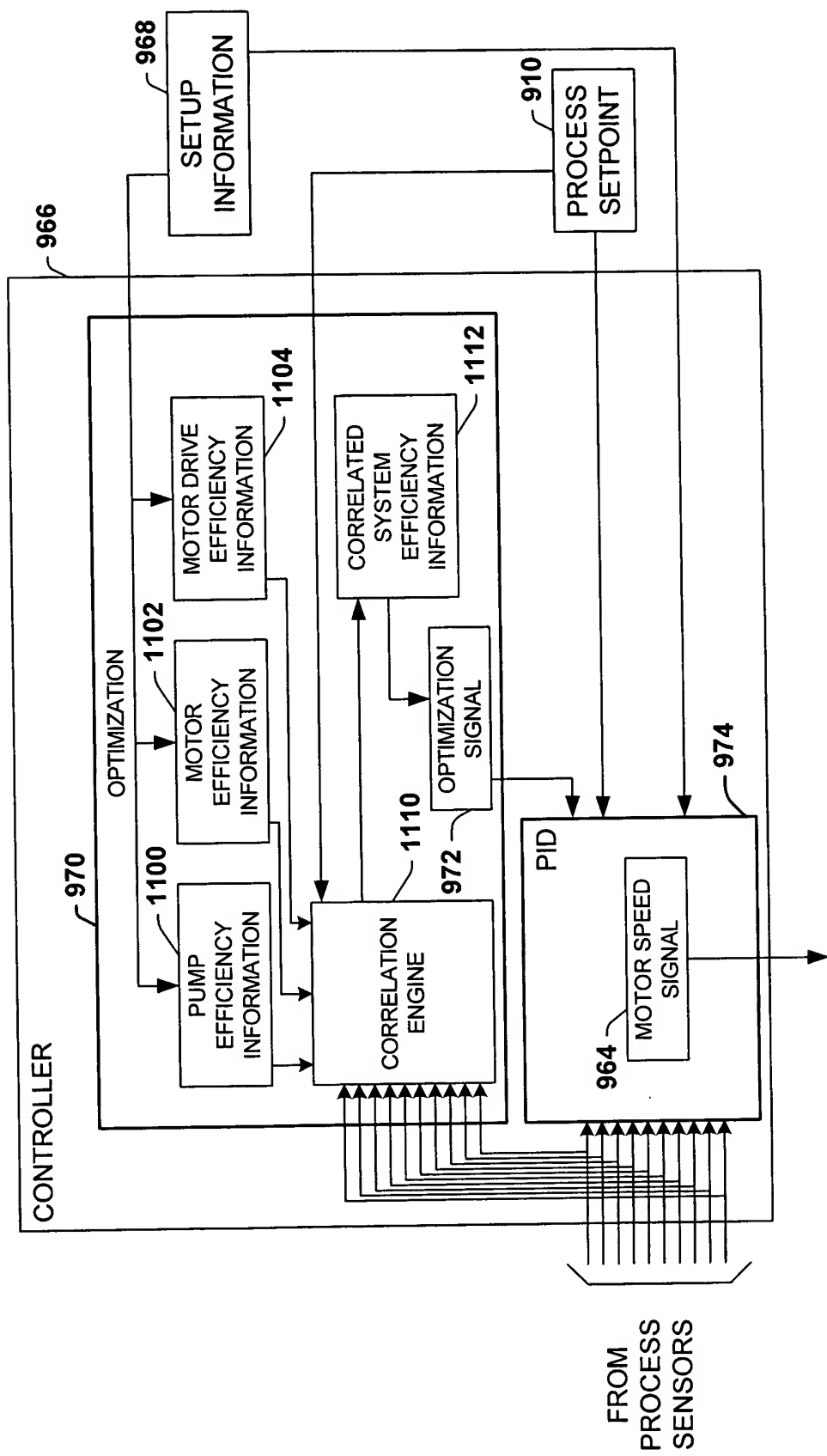


FIG. 9





**FIG. 11**

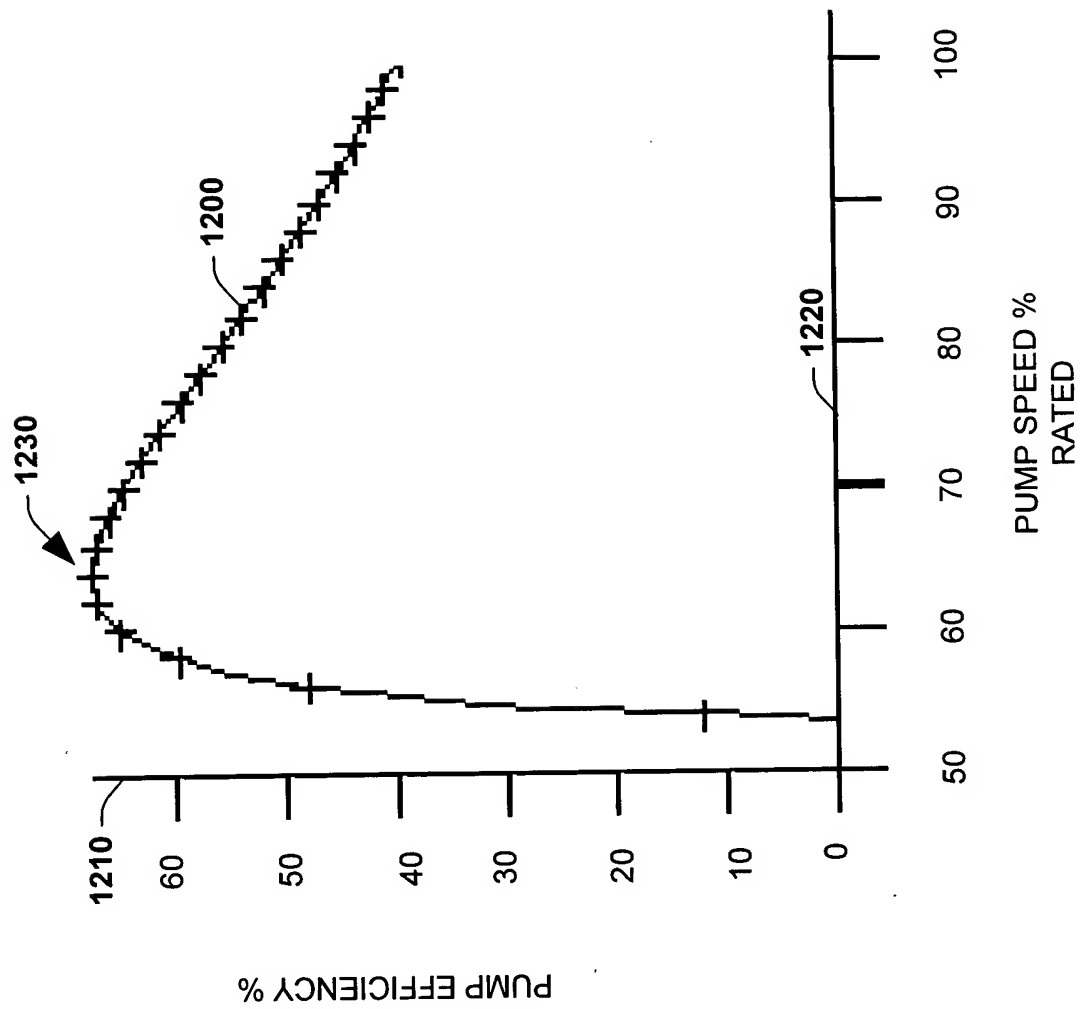


FIG. 12

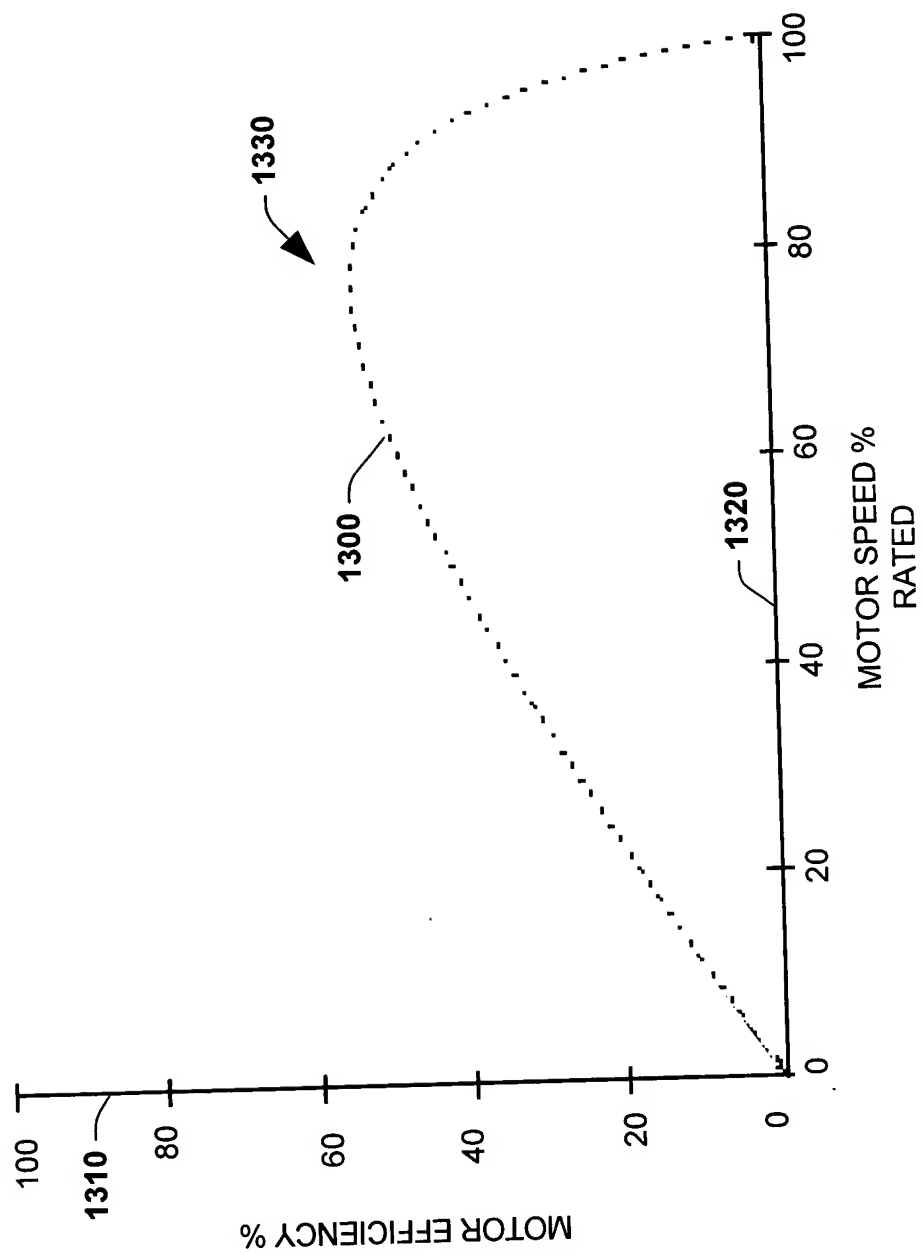
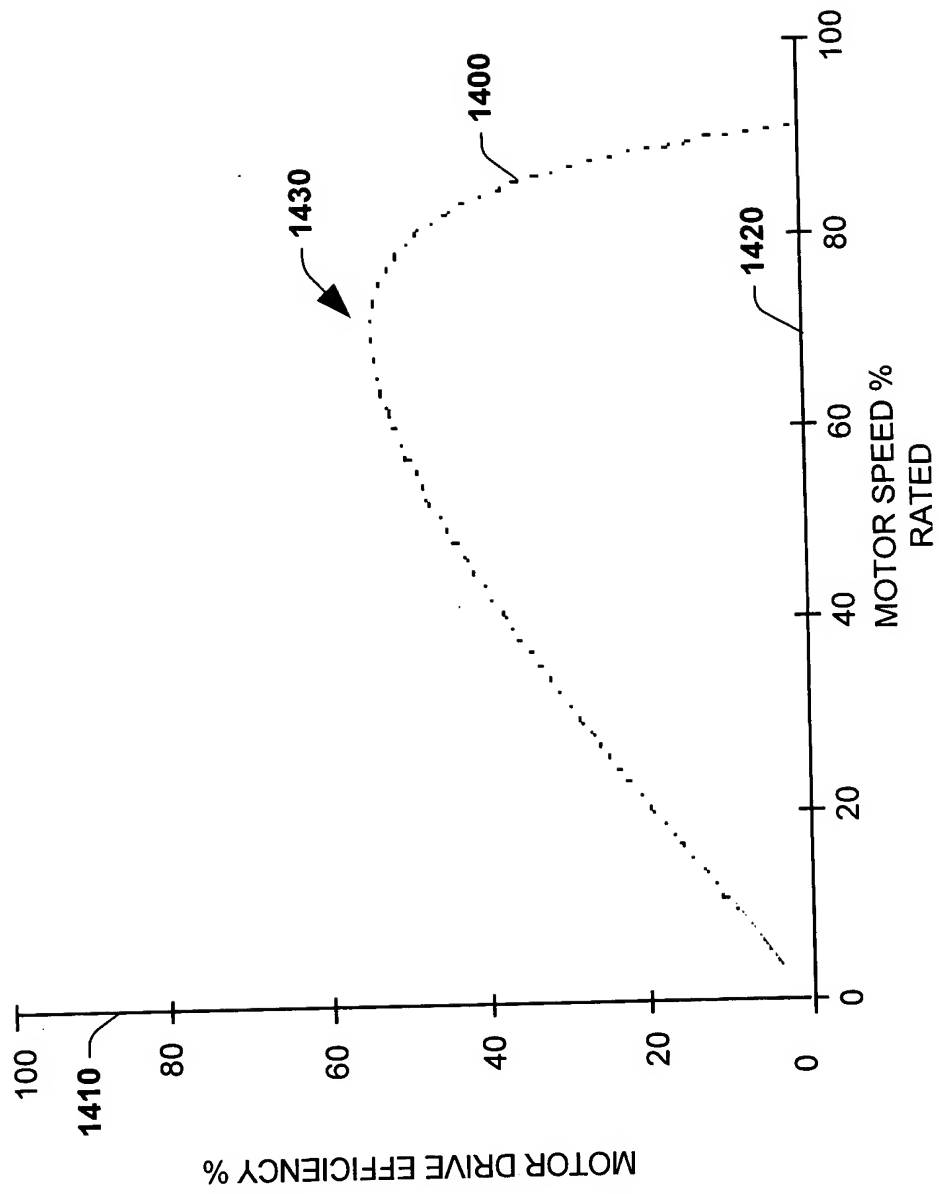


FIG. 13



**FIG. 14**



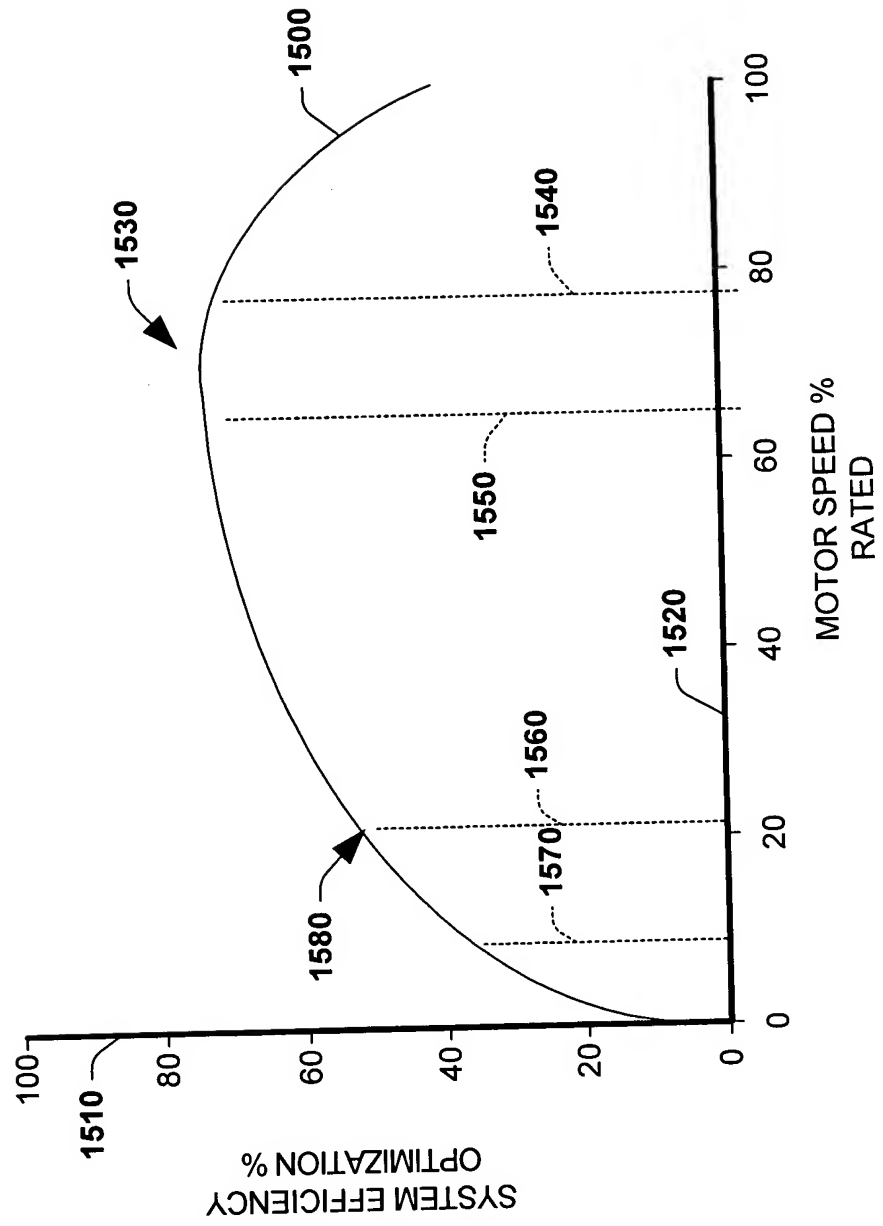


FIG. 15

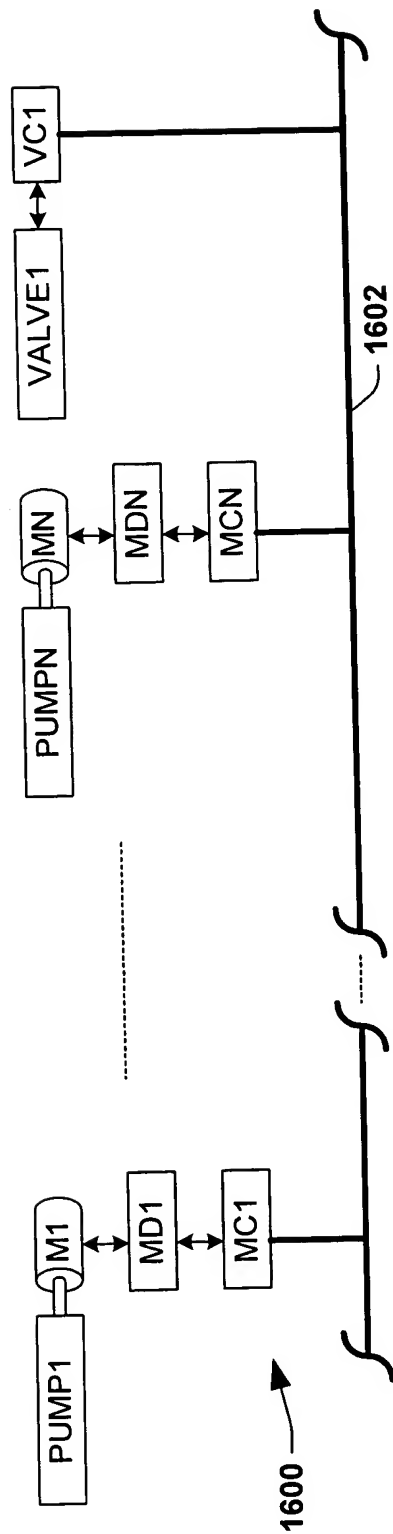


FIG. 16

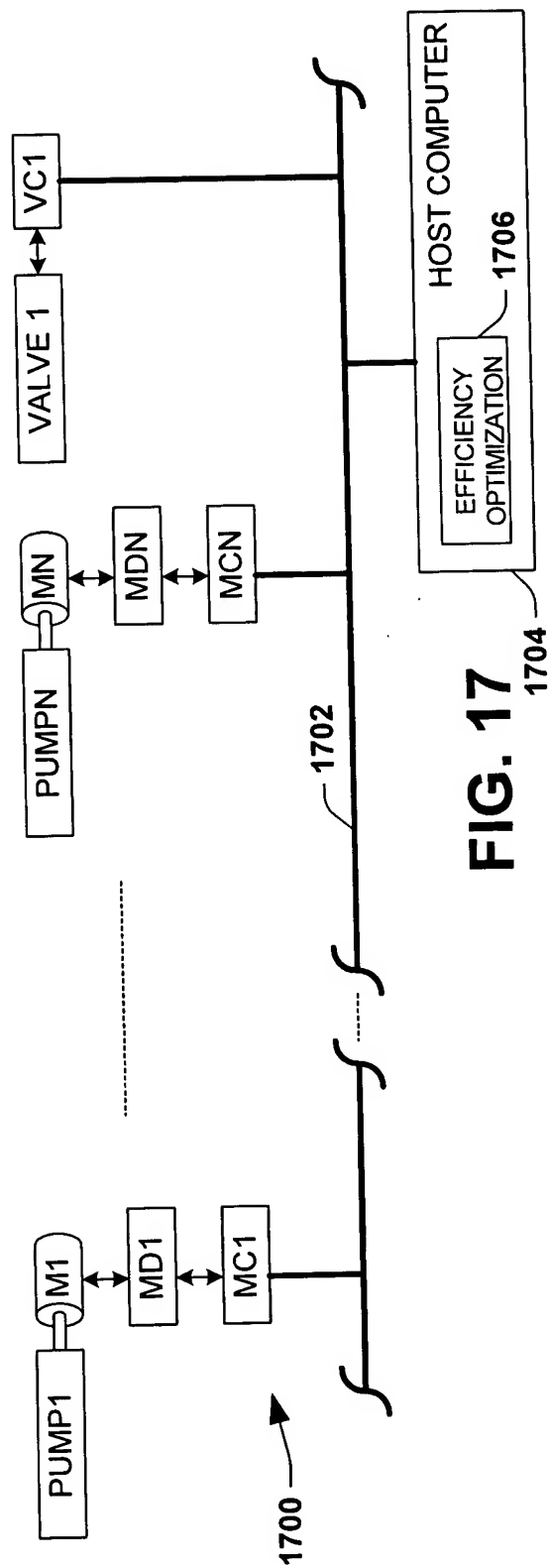
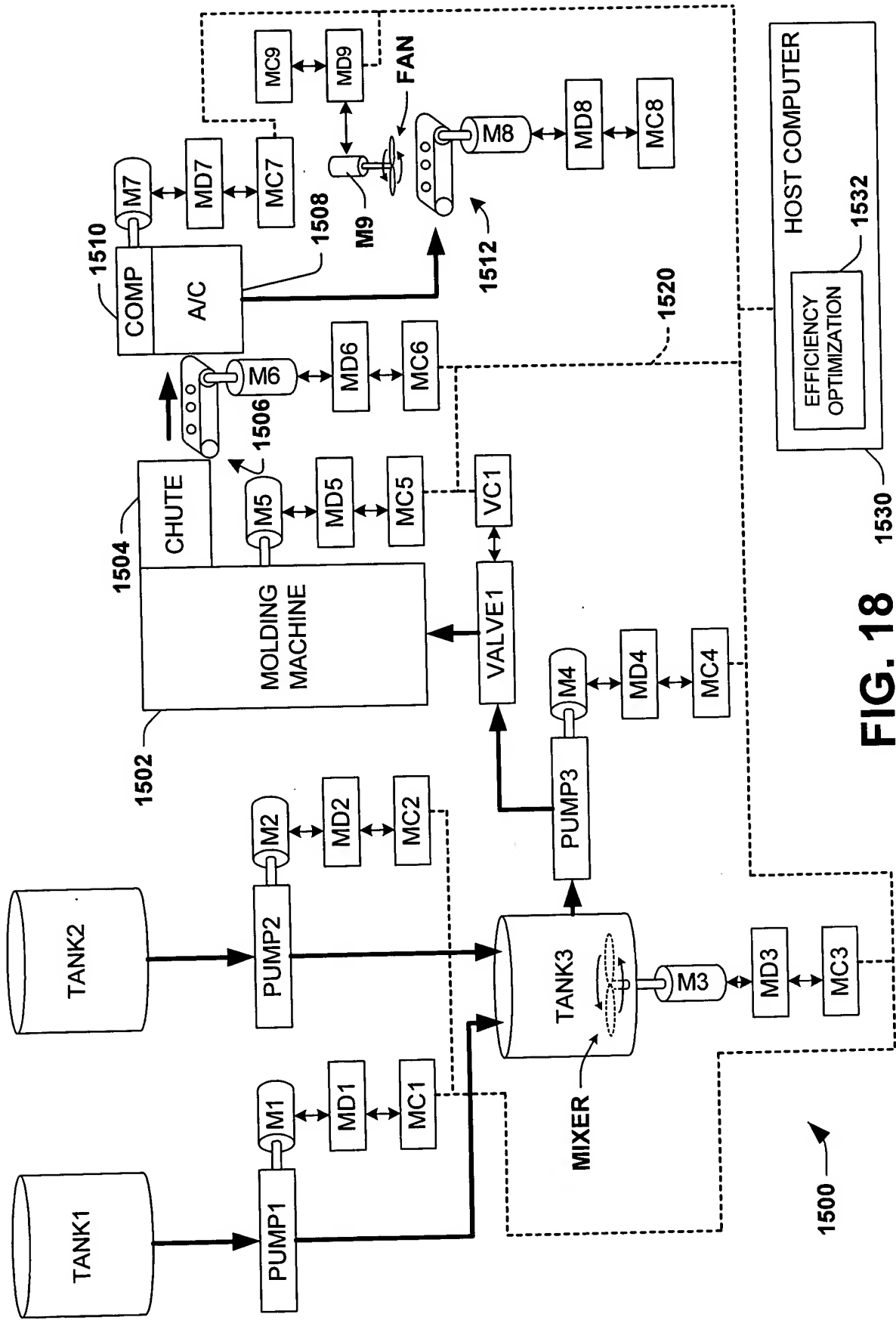
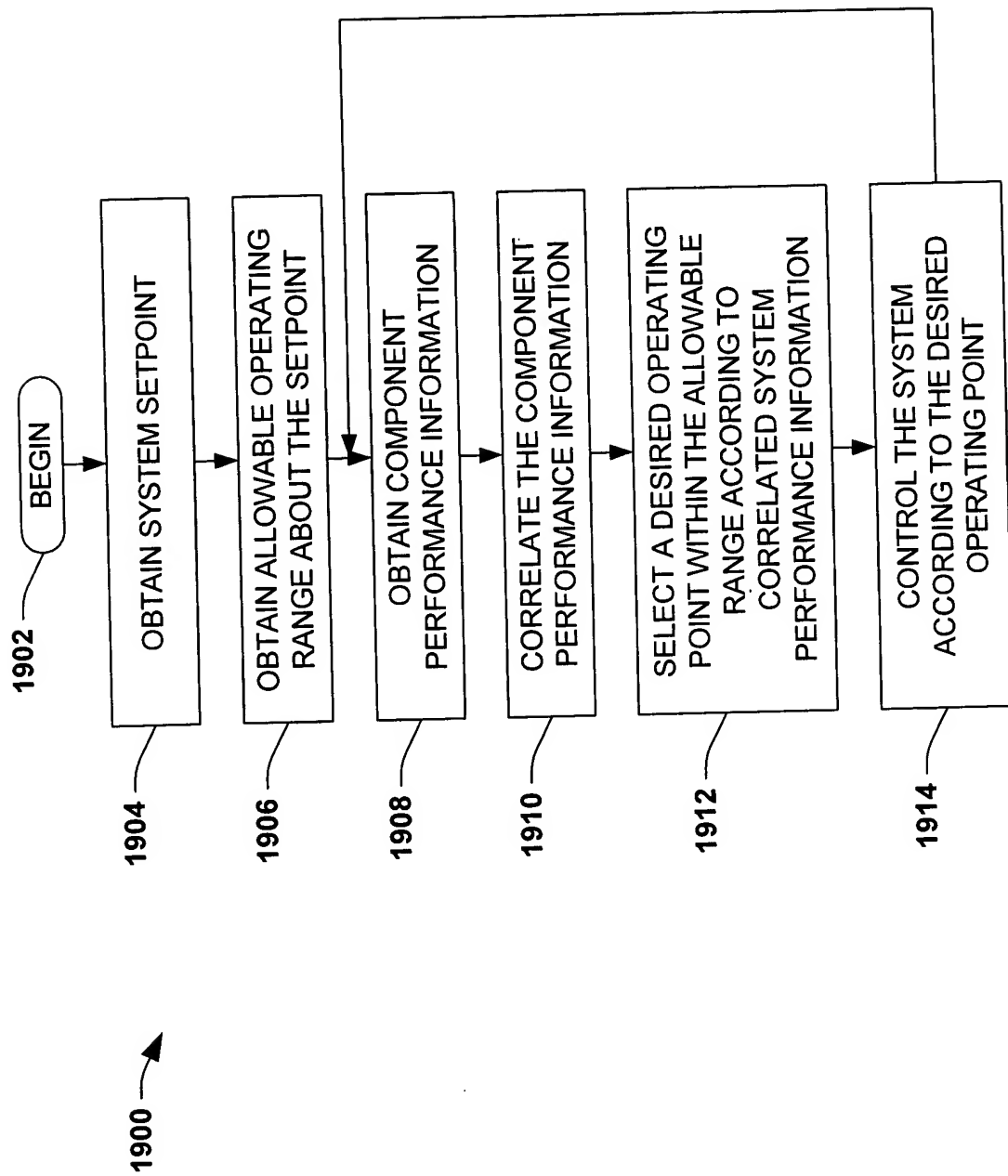


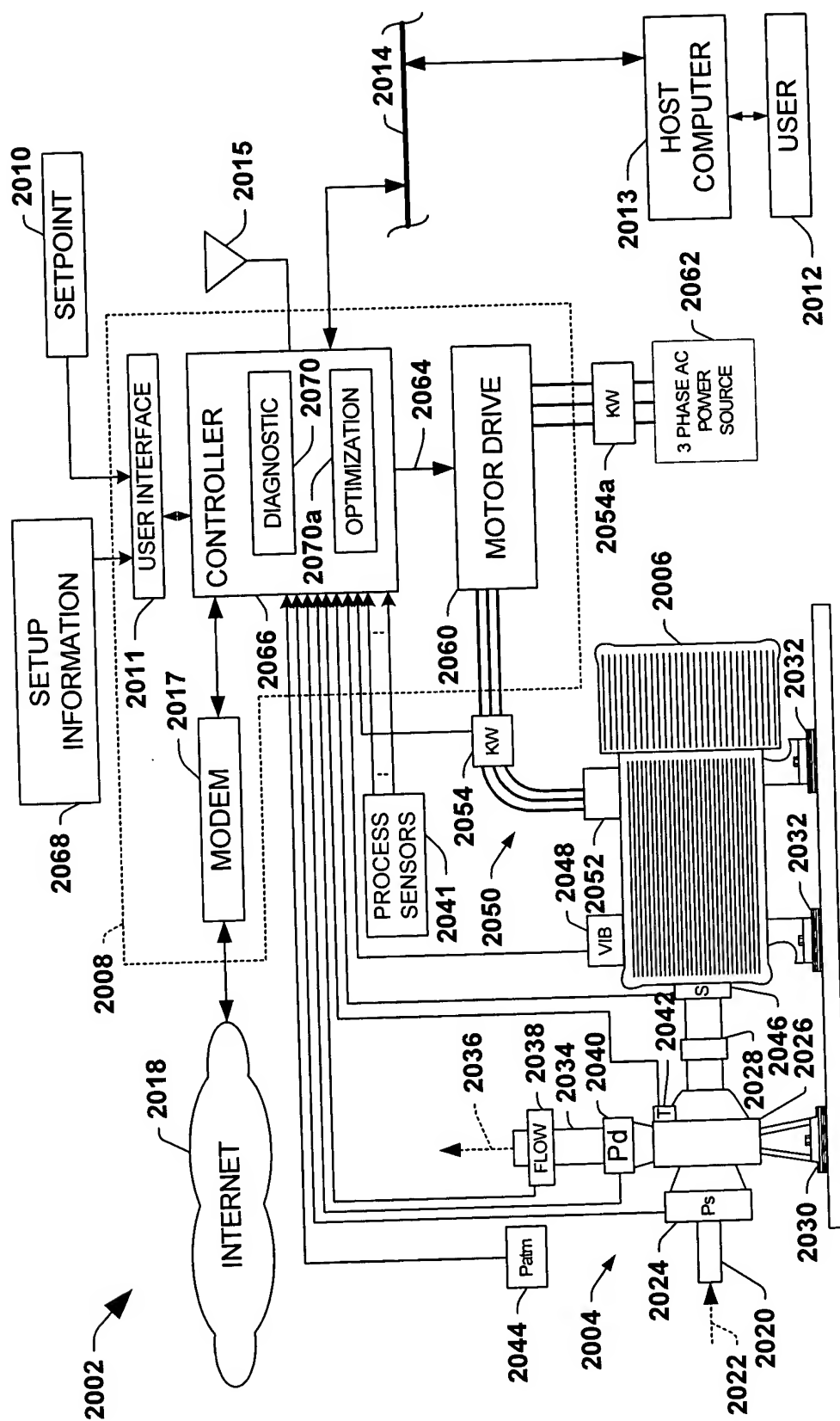
FIG. 17



**FIG. 18**



**FIG. 19**



**FIG. 20**